Receipt Number
536684

22

UNITED DISTRICT COURT
FOR THE EASTERN DISTRICT OF MICHIGAN
SOUTHERN DIVISION

ILJIN USA,

Plaintiff,

v.

NTN CORPORATION,

Defendant.

Case: 2:06-cv-10145
Assigned To : Roberts, Victoria A
Referral Judge: Pepe, Steven D
Assign. Date : 01/10/2006
Description: CMP ILJIN USA V. NTN CORP (TAM)

FILED
JAN 10 2006
CLERK'S OFFICE, DETROIT-PSG
U.S. DISTRICT COURT

COMPLAINT FOR DECLARATORY JUDGMENT

Plaintiff, ILJIN USA, by and through its attorneys complains of the Defendant, NTN CORPORATION, and alleges as follows:

THE PARTIES

1. Plaintiff, ILJIN USA is a corporation duly organized and existing under the laws of the State of Michigan and having a principal place of business at 28055 Haggerty Road, Novi, Oakland County, Michigan within this judicial district and division.

2. Defendant NTN CORPORATION is, on information and belief, a corporation organized and existing under the laws of Japan and transacting business in this judicial district either directly and/or through a related and/or affiliate entity located at 39255 W 12 Mile Road, Farmington Hills, Oakland County, Michigan within this judicial district and division.

NATURE OF THIS SUIT

3. This is a suit for declaratory judgment of invalidity and non-infringement of a United States Patent brought pursuant to the Declaratory Judgment Act, Title 28, U.S.C., Section 2201.

JURISDICTION AND VENUE

4. This Court has original and exclusive jurisdiction pursuant to Title 28, U.S.C. Section 1338 because this action also arises under the Patent Laws of the U.S. (Title 35, U.S.C. Section 1 *et seq.*) and pursuant to the Declaratory Judgment Act, 28 U.S.C. 2201.

5. This Court has personal jurisdiction over the Defendant because the Defendant, a Japanese Corporation, transacts business on a regular basis and has a regular and established place of business in Novi, Oakland County, Michigan within this judicial district and division.

6. Venue is proper in this judicial district and division under 28 U.S.C. Section 1391(b,c,d) because the Defendant resides in this judicial district and division, a substantial part of the events given rise to the claim occurred in this judicial district and division, and because Defendant is an alien corporation.

CLAIM AGAINST DEFENDANT

7. Defendant, NTN CORPORATION, claims to own all rights, title and interest in and to U.S. Letters Patent No.: 5,620,263, a copy of which is attached as Exhibit 1.

8. Defendant has asserted infringement of said United States Letters Patent against Plaintiff and Plaintiff's parent company thereby creating a justifiable controversy which is a cloud upon Plaintiff's business and which will interfere with and harm Plaintiff's business.

9. Defendant has initiated an action, as Complainant, at the United States International Trade Commission now identified as "In the Matter of Certain Axle Bearing Assemblies, Components Thereof and Products Containing the Same", Investigation No. 337 TA 554, asserting infringement of said U.S. Letters Patent against Plaintiff, Plaintiff's parent company, and *inter alia*, the products imported and/or sold by Plaintiff and Plaintiff's parent company.

10. Plaintiff and Plaintiff's parent company are the only Respondents in the International Trade Commission Investigation No. 337 TA 554 referred to in the preceding paragraph.

11. The Plaintiff, in its capacity as Respondent at the International Trade Commission, cannot obtain full and complete relief at the International Trade Commission. By way of example and not by way of limitation, there are statutory limitations on the jurisdiction of the International Trade Commission and Rules promulgated by the International Trade Commission which, *inter alia* can preclude the decision of the International Trade Commissions from having *res judicata* effect.

12. Defendant has asserted infringement only of Claim 1 of the U.S. Letters Patent No. 5,620,263 in the aforementioned International Trade Commission investigation referred to in paragraph 9.

13. On information and belief U.S. Letters Patent No. 5,620,263 and the asserted claim thereof are invalid pursuant to Title 35 U.S.C. 101,102,103 and 112.

14. The asserted claim of the U.S. Letters Patent No. 5,620,26 is not and has not been infringed by Plaintiff, Plaintiff's parent corporation or any products of Plaintiff and/or Plaintiff's parent corporation.

15. On information and belief U.S. Letters Patent No. 5,620,263 is unenforceable for, *inter alia*, the failure of Defendant to disclose the most relevant prior art of which it was aware to the United States Patent and Trademark Office.

WHEREFORE, Plaintiff prays as follows:

a. For declaration and judgment that the asserted claim of U.S. Letters Patent No. 5,620,263 is invalid;

b. For declaration and judgment that the asserted claim of U.S. Letters Patent No. 5,620,263 is not infringed;

c. For declaration and judgment that U.S. Letters Patent No. 5,620,263 is unenforceable;

d. For declaration and judgment that the Plaintiff has not at any time infringed the asserted claim of the U.S. Letters Patent No. 5,620,263;

e. For declaration and judgment that it is the right of Plaintiff, its parent company, and its customers to continue their businesses without any further actions, threat or interference of any kind or nature by Defendant, or anyone claiming through or under Defendant, on account of U.S. Letters Patent No. 5,620,263 or any of the claims thereof or any alleged infringement thereof;

f. For an injunction preliminarily and permanently restraining and enjoining Defendant from asserting, threatening or otherwise relying upon U.S. Letters Patent No. 5,620,263 against Plaintiff, Plaintiff's parent company and/or the customers of either of them;

g. For a declaration of rights with respect to the right of Plaintiff and its parent company to continue with business activities without interference or threat by Defendant;

h. That Plaintiff have judgment for its costs of this suit and for its reasonable attorney fees;

i. That this case be deemed exceptional pursuant to Title 35 U.S.C. Section 285 and that Plaintiff recover its actual attorneys fees; and

j. For such other and further relief as to this Court appears just and proper.

Respectfully submitted,

AKERMAN SENTERFITT
Attorneys for Plaintiff, ILJIN USA

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222 Lakeview Avenue, Suite 400
West Palm Beach, FL 33401-6183
Phone: (561) 653-5000
Fax: (561) 659-6313

Dated: January 10, 2006

DETROIT.2050002.1

FIG. 1

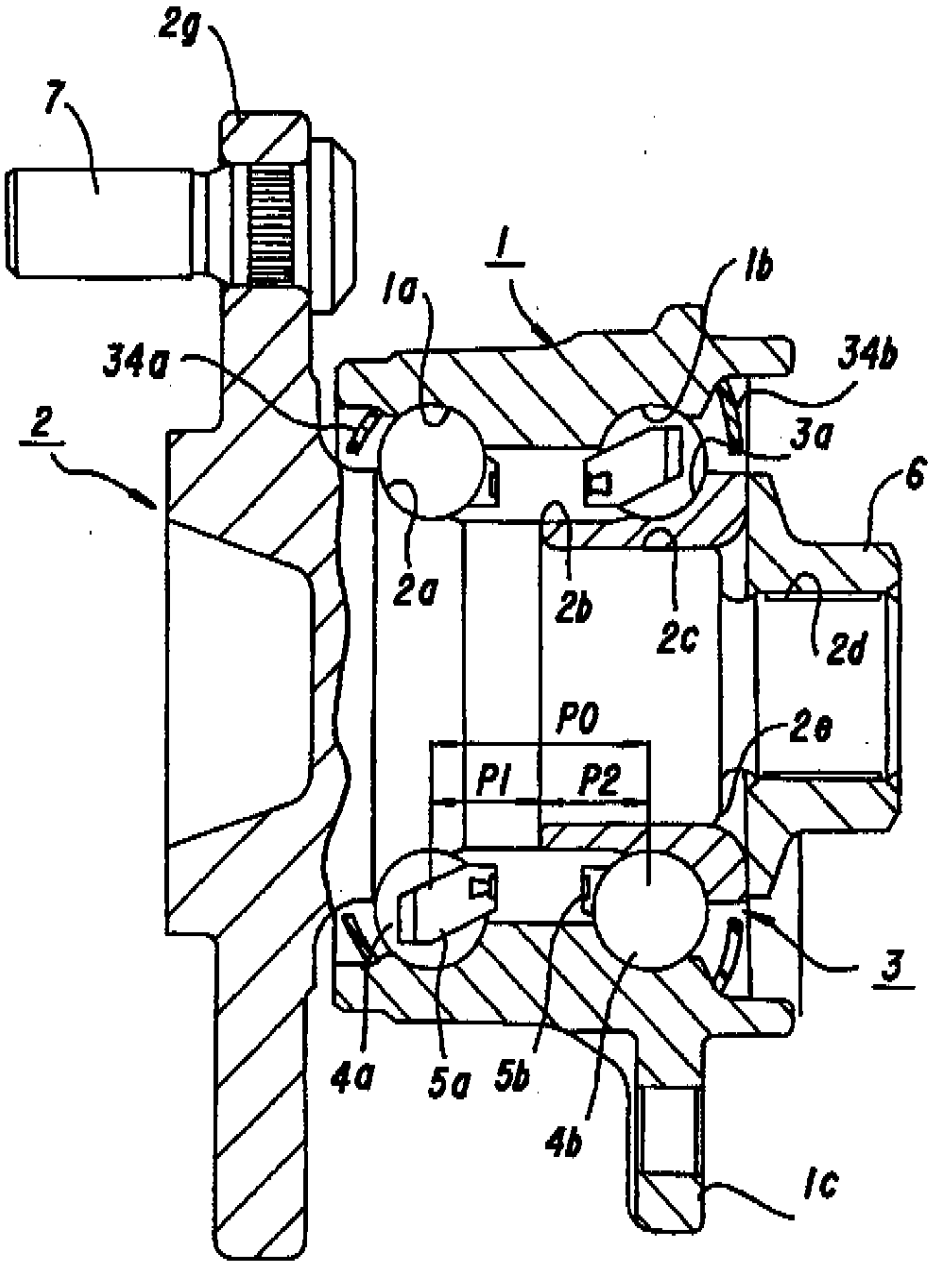


FIG.2

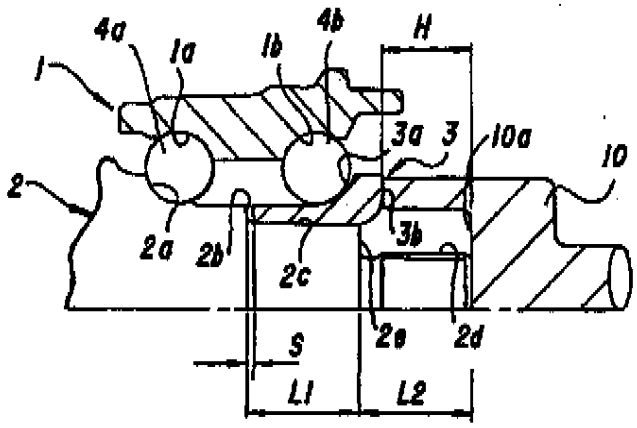


FIG.3

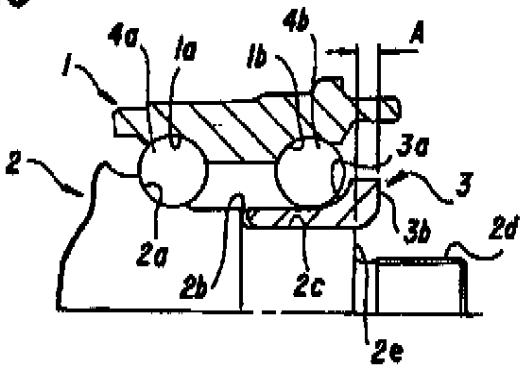


FIG.4

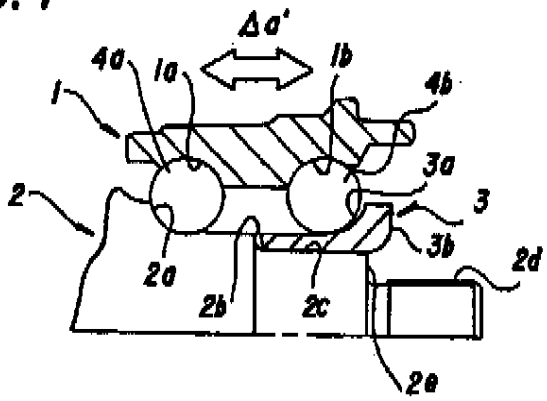


FIG.5

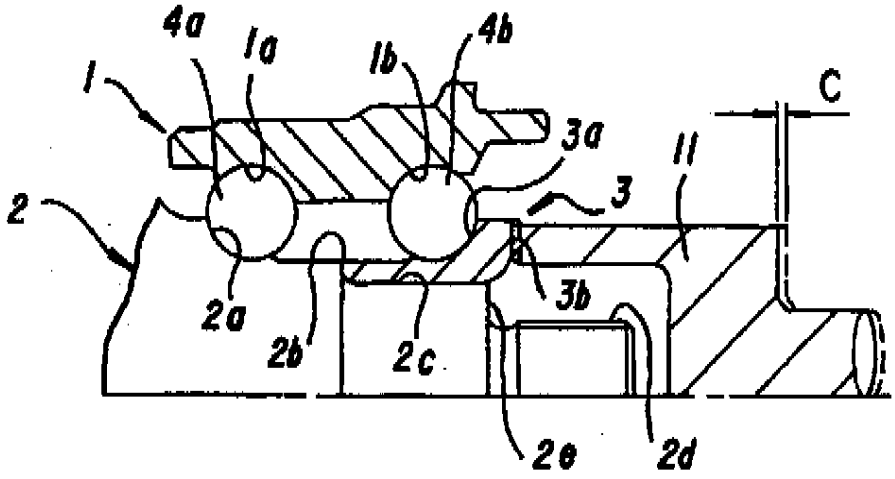

4a
1a
1b
4b
1
C
3a
11
3
2
3b
2a
2b
2c
2e
2d

FIG.6

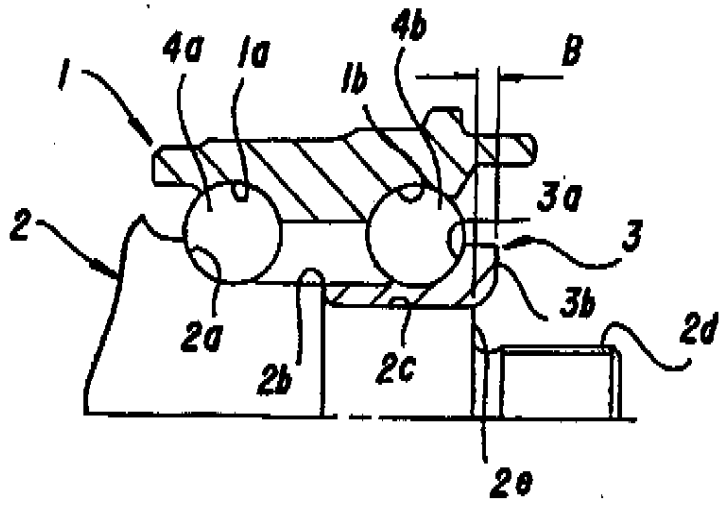

4a
1a
4b
B
1
1b
3a
3
2
3b
2d
2a
2b
2c
2e

FIG.7

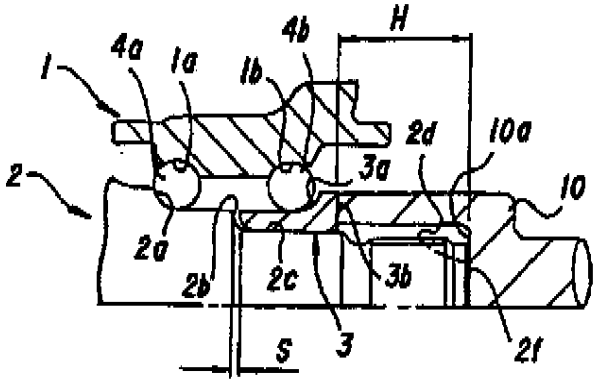


FIG.8

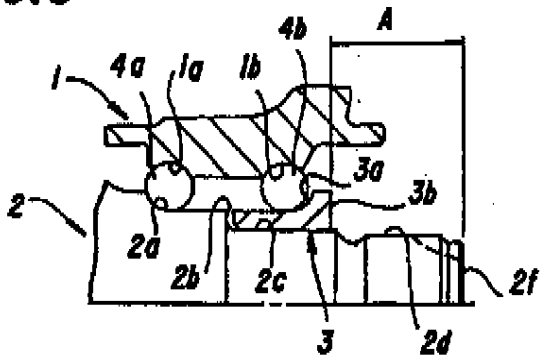


FIG.9

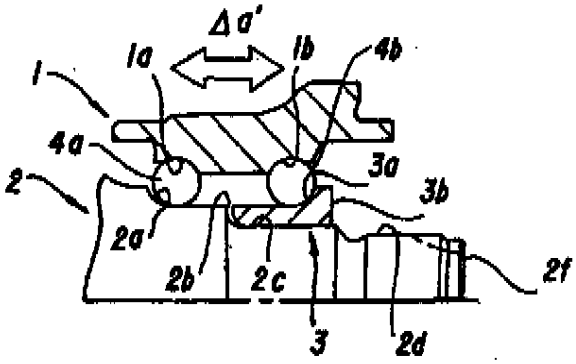


FIG.10

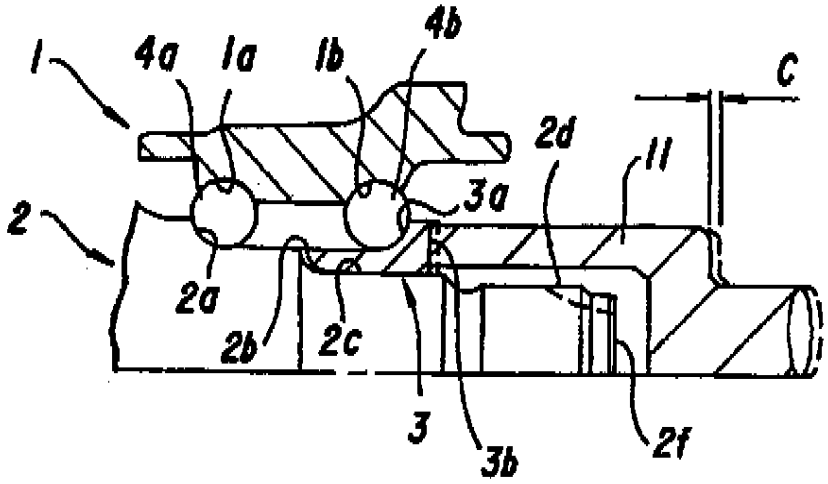

1
4a
1a
1b
4b
C
2d
11
3a
2
2a
2b
2c
3
3b
2f

FIG.11

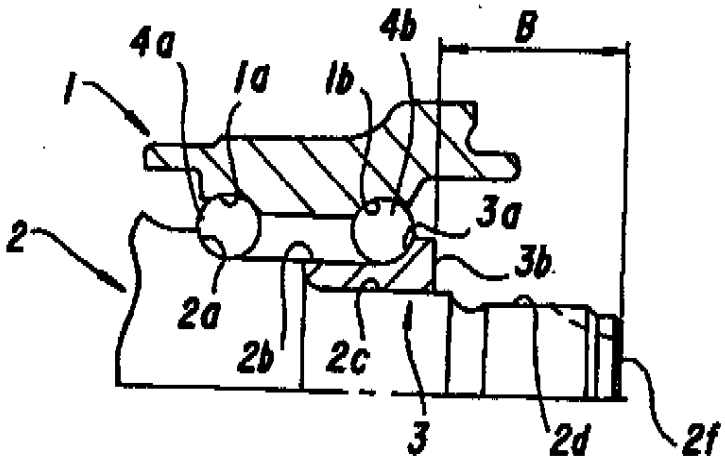

4a
4b
B
1
1a
1b
3a
2
3b
2a
2b
2c
3
2d
2f

FIG.12

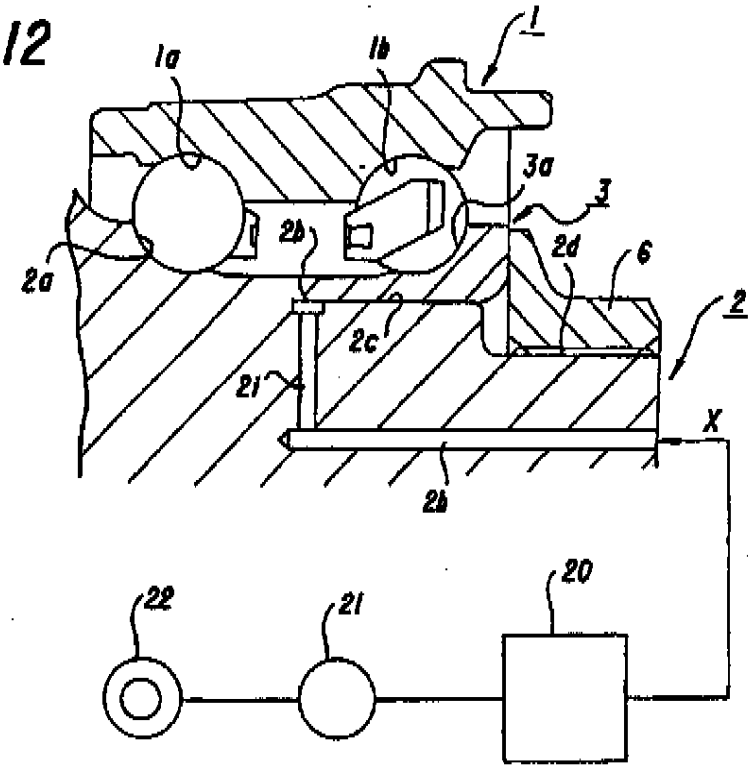


FIG.14

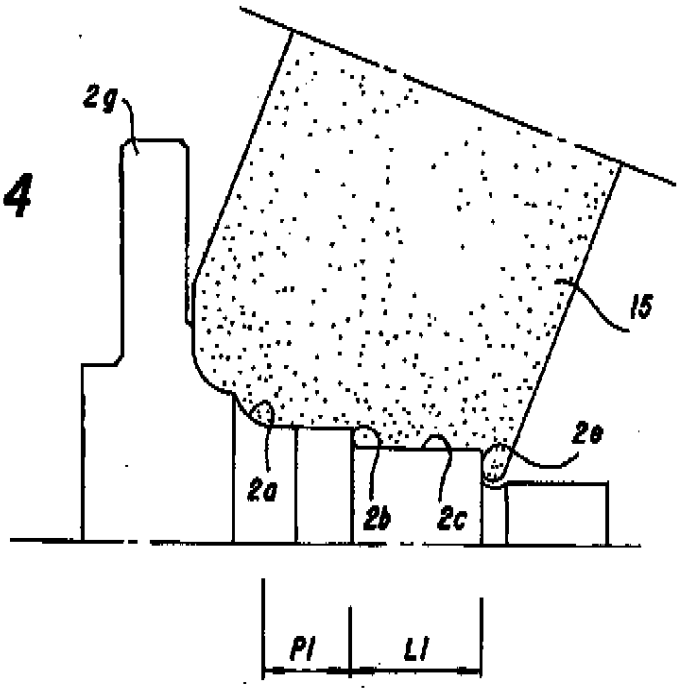


FIG.13A

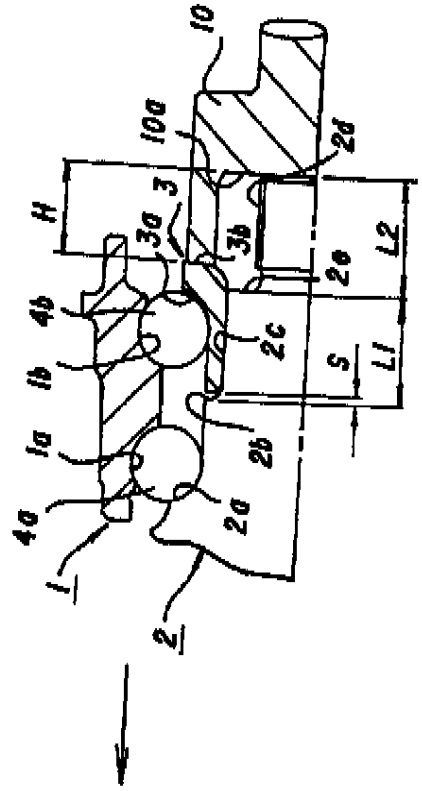


FIG.13D

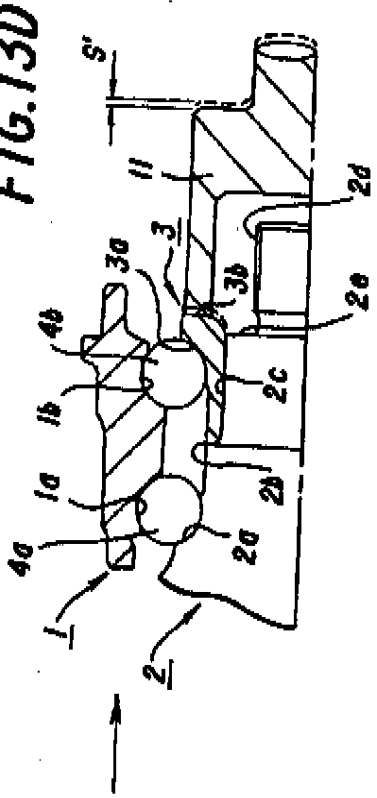


FIG.13B

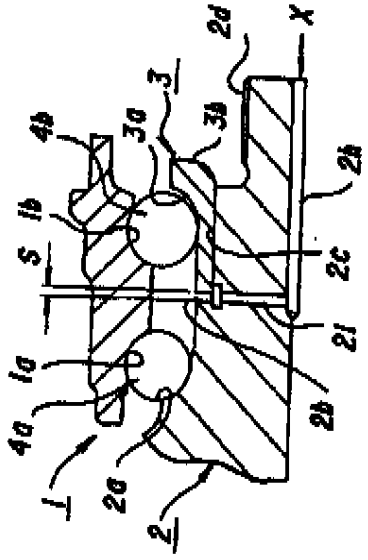


FIG.13C

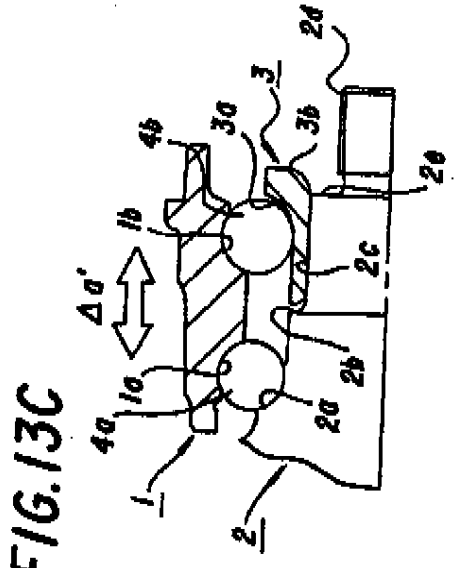


FIG.15
PRIOR ART

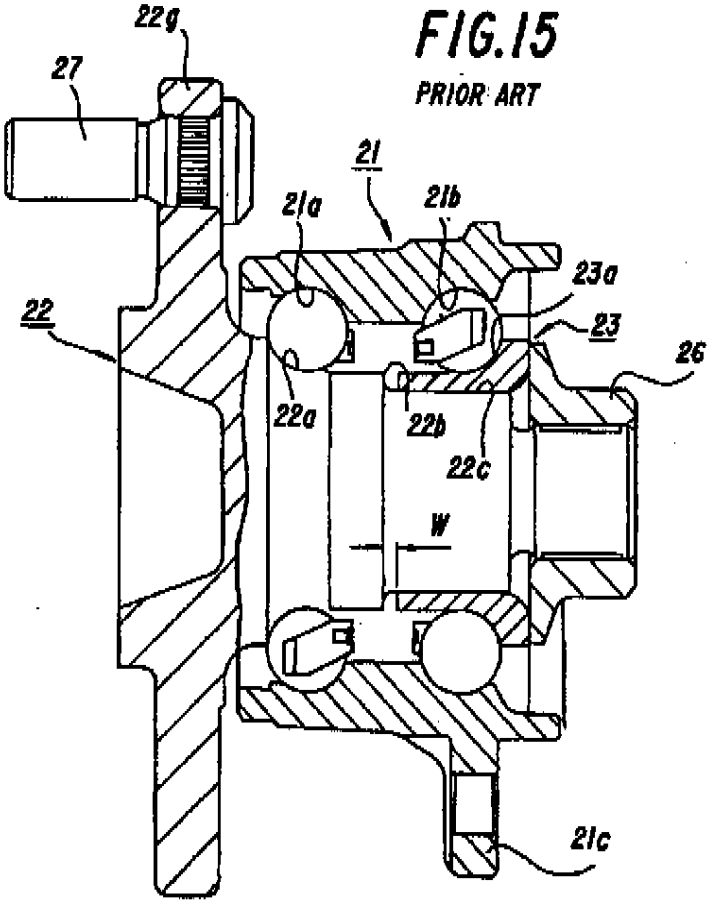
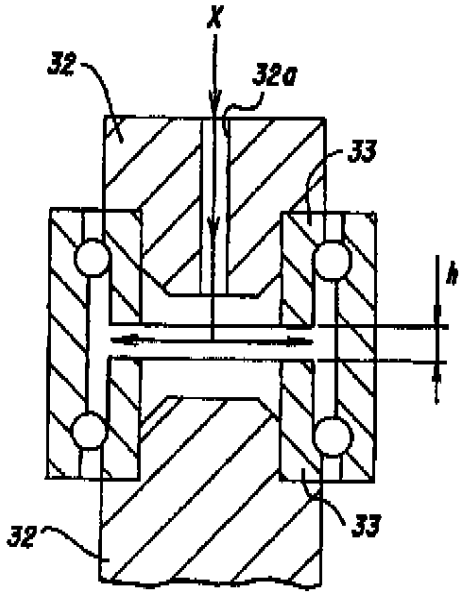


FIG.16
PRIOR ART



AXLE BEARING ASSEMBLY AND METHOD OF MEASURING BEARING CLEARANCES

BACKGROUND OF THE INVENTION

The present invention relates to an axle bearing assembly for supporting a wheel of an automobile, and particularly it relates to an axle bearing assembly used for wheels of the type in which a raceway surface is formed directly on the axle, and to a method of measuring bearing clearances.

As an example, in a conventional axle bearing assembly shown in FIG. 15, the inner periphery of an outer ring 21 is formed with two rows of raceway surfaces 21*a* and 21*b*, and a raceway surface 23*a* opposed to the raceway surface 21*b* is formed on the outer periphery of an inner ring 23 while a raceway surface 22*a* opposed to the raceway surface 21*a* is directly formed on the outer periphery of an axle 22. The outer ring 21 is integrally formed around its outer periphery with a flange 21*c* to be fixed to the body of an automobile or the like, while the axle 22 is integrally formed around the outer periphery of the end thereof with a flange 22*g* for mounting a hub bolt 27 thereon. Further, the axle 22 is formed on substantially the central outer periphery thereof with the raceway surface 22*a* and also with a press-fit portion 22*c* continuous therewith through a shoulder portion 22*b* and adapted to have the inner ring 23 press-fitted thereon. The inner ring 23 is press-fitted on the press-fit portion 22*c* of the axle 22 and fixed in position by a nut 26 screwed on the end of the axle 22.

In this connection, in this kind of bearing assembly, considering the rolling life, rigidity, and fretting of the bearing, the advantageous use of the bearing is with a negative axial bearing clearance, i.e., with a predetermined preload; however, since it is difficult from the viewpoint of controlling the clearance to measure a negative bearing clearance, it has been common practice to predetermine an initial bearing clearance by allowing for a decrease in the bearing clearance by press-fitting the inner ring 23 on the press-fit portion 22*c* or by tightening by means of the nut 26. That is, the tightening torque to be applied to the nut 26 corresponding to the desired amount of preload is preset, and the inner ring 23 is forced toward the shoulder portion 22*b* of the axle 22 until the tightening torque on the nut 26 reaches this preset value. Accordingly, if such preload (bearing clearance) control means is used, it is essential that upon completion of the press fitting, a spacing W be present between the front face of the inner ring 23 and the shoulder portion 22*b* of the axle 22.

Generally, in a double row angular contact ball bearing having a pair of inner rings, since the relative position between the pair of inner and outer rings determines the bearing clearance (amount of preload), the bearing clearance (negative bearing clearance) can be measured, e.g., in the manner shown in FIG. 16. That is, with the pair of inner rings 33 held by a shaft member 32 for measurement so as to reduce the axial bearing clearance of the bearing to zero, compressed air X is blown out of the spacing h between the inner rings 33 through an air passage 32*a* provided in the shaft member 32, and then the spacing h is found from the detected value of the back pressure of the compressed air X or the like; thus, the negative bearing clearance (=h) which is present upon completion of the assembly can be found. However, in a bearing assembly as shown in FIG. 15, since the bearing clearance is determined by the amount of press-fitting of the inner ring 23 on the axle 22, it is impossible to use the above-described measuring method as it is. Herein lies the reason why the indirect clearance control has been made in this kind of bearing by the tightening torque on the nut.

SUMMARY OF THE INVENTION

In a conventional axle bearing assembly, even if the optimum preload (optimum bearing clearance) is determined from the viewpoint of the bearing life and rigidity, there is no means for measuring it, and there is a variation in tightening torque on the nut; therefore, problems on reliability still remain to be solved. Further, since the spacing W is present between the inner ring 23 and the shoulder portion 22*b*, in operation, the inner ring 23 moves slightly toward the shoulder portion 22*b*, thus leading to a danger of more preload than necessary being imposed on the bearing.

An object of the invention is to increase the reliability of this type of bearing assembly by providing a construction which assures a negative bearing clearance in an axle bearing assembly as described above and by providing a clearance measuring method.

In order to attain the object described above, the present invention provides an axle bearing assembly characterized in that an inner ring is press-fitted until it abuts against the shoulder portion of the axle and in that the bearing clearance is negative.

Further, the present invention is intended to provide a bearing clearance measuring method comprising, in press-fitting an inner ring on the press-fit portion of an axle, the steps of once stopping the press fitting while the axial bearing clearance is positive, measuring the axial dimension (A) in this state between a reference surface for the axle and a reference surface for the inner ring and a axial bearing clearance ($\Delta a'$) and measuring, upon completion of the press-fitting of the inner ring, the axial dimension (B) between the reference surface for the axle and the reference surface for the inner ring, thereby finding a negative axial bearing clearance (Δa) present upon completion of the assembly from the formula, $\Delta a=\Delta a'-(A-B)$.

Further, the present invention provides a bearing clearance measuring method comprising, in press-fitting the inner ring on the press-fit portion of the axle, the steps of once stopping the press fitting while the axial bearing clearance is positive, measuring the axial bearing clearance ($\Delta a'$) in this state, and measuring the amount of press-fitting stroke (C) continuing from this state to completion of the press-fitting of the inner ring, thereby finding the negative axial bearing clearance (Δa) present upon completion of the assembly from the formula, $\Delta a=\Delta a'-C$.

Further, the invention provides a bearing clearance measuring method comprising, in forming the axle with an air passage which opens to the outside in the vicinity of the shoulder portion and press-fitting the inner ring on the press-fit portion of the axle, the steps of once stopping the press fitting while the axial bearing clearance is positive, finding the spacing (S) in this state between the shoulder portion of the axle and the end surface of the inner ring opposed thereto from measured values such as the back pressure and the amount of flow or flow rate of compressed air blown out of the spacing (S) through said air passage, measuring the axial bearing clearance ($\Delta a'$) in this state, and press-fitting the inner ring until it abuts against the shoulder portion of the axle, thereby finding the negative axial bearing clearance (Δa) from the formula, $\Delta a=\Delta a'-S$.

In the assembling process of bearings, the negative bearing clearance can be reliably measured by once stopping the

press fitting of the inner ring while the axial bearing clearance is positive, measuring the axial bearing clearance in this state, measuring the amount of press fitting continuing to completion of the press fitting of the inner ring, and subtracting said amount of press fitting from this bearing clearance.

The amount of press fitting continuing to completion of the press fitting of the inner ring can be found by measuring the axial dimension between the reference surface formed on the axle and the reference surface for the inner ring or by directly measuring the amount of the press-fitting stroke for the inner ring.

Further, in the assembling process of the bearing, the negative bearing clearance can be reliably measured by once stopping the press fitting of the inner ring while the axial bearing clearance is positive, measuring in this state the spacing (S) between the shoulder portion of the axle and the end surface of the inner ring opposed thereto and also measuring the axial bearing clearance, measuring the amount of press fitting (S'-S) continuing to completion of the press fitting of the inner ring, and subtracting said amount of press fitting from this bearing clearance. The measurement of the spacing (S) is made by blowing the compressed air out of the spacing (S) through the air passage formed in the axle, and detecting the back pressure and the amount of flow or flow rate of the compressed air.

According to the invention, since the negative bearing clearance is found by once stopping the press fitting of the inner ring while the axial bearing clearance is positive, measuring the axial bearing clearance in this state and subtracting the amount of press fitting continuing to completion of the press fitting of the inner ring from this bearing clearance, the negative bearing clearance can be accurately and easily measured even if rigid control of the tightening torque is not made.

Further, since the negative bearing clearance is reliably assured, it is possible to increase the initial bearing clearance to thereby decrease the rate of defectiveness.

Further, even in the construction in which the inner ring is pressed against the shoulder portion of the axle, measurement of the negative bearing clearance is possible; therefore, the stable negative bearing clearance can be maintained while avoiding deviation of the inner ring due to its slight vibration.

Further, the bearing clearance can be reliably and easily measured by detecting the back pressure or the amount of flow or flow rate of compressed air blown out of the spacing (S) through the air passage in the axle.

The bearing assembly in which the inner ring is pressed against the shoulder portion of the axle and which assures that the bearing clearance is negative is remarkably high in reliability from the view points of bearing life, rigidity and fretting.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view showing an axle bearing assembly for according to an embodiment of the invention;

FIG. 2 is a sectional view showing one process in a first embodiment of the bearing clearance measuring method according to the invention;

FIG. 3 is a sectional view showing one process in the first embodiment of the bearing clearance measuring method according to the invention;

FIG. 4 is a sectional view showing one process in the first embodiment of the bearing clearance measuring method according to the invention;

FIG. 5 is a sectional view showing one process in the first embodiment of the bearing clearance measuring method according to the invention;

FIG. 6 is a sectional view showing one process in the first embodiment of the bearing clearance measuring method according to the invention;

FIG. 7 is a sectional view showing one process in a second embodiment of the bearing clearance measuring method according to the invention;

FIG. 8 is a sectional view showing one process in the second embodiment of the bearing clearance measuring method according to the invention;

FIG. 9 is a sectional view showing one process in the second embodiment of the bearing clearance measuring method according to the invention;

FIG. 10 is a sectional view showing one process in the second embodiment of the bearing clearance measuring method according to the invention;

FIG. 11 is a sectional view showing one process in the second embodiment of the bearing clearance measuring method according to the invention;

FIG. 12 is a fragmentary enlarged sectional view showing the third embodiment of the axle bearing assembly according to the invention;

FIGS. 13A through 13D are sectional views showing a third embodiment of the present invention, illustrating a bearing clearance measuring method in the order of processing;

FIG. 14 is a view showing an axle manufacturing process;

FIG. 15 is a sectional view showing a conventional axle bearing assembly; and

FIG. 16 is a sectional view showing a conventional example of a bearing clearance measuring method in a double row angular contact ball bearing having a pair of inner rings.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Embodiments of the invention will now be described.

An axle bearing assembly shown in FIG. 1 is one in which a negative bearing clearance has been assured by using a bearing clearance measuring method according to the present invention to be later described. This bearing assembly comprises an outer ring 1 having two rows of raceway surfaces 1*a* and 1*b* formed on the inner periphery, an inner ring 3 having a raceway surface 3*a* formed on the outer periphery opposed to the raceway surface 1*b* of the outer ring 1, an axle 2 having a raceway surface 2*a* opposed to the raceway surface 1*a* of the outer ring 1 and a press-fit portion 2*c* continuous therewith through a shoulder portion 2*b* and adapted to have the inner ring 3 press-fitted thereon, two rows of balls 4*a* and 4*b* interposed between the outer ring 1 and the axle 2 and between the outer ring 1 and the inner ring 3, retainers 5*a* and 5*b* which retain the balls 4*a* and 4*b*, and a nut 6 threadedly fitted on the outer periphery of the end of the axle 2. Further, the outer periphery of the outer ring is integrally formed with a flange 1*c* adapted to be fixed to the body of an automobile or the like. The outer periphery of one end of the axle 2 is integrally peripherally formed with a flange 2*g* for mounting a hub bolt 7, while the outer periphery of the other end is provided with a threaded portion 2*d* for threaded engagement with the nut 6. The inner ring 3 is press-fitted on the press-fit portion 2*c* of the axle 2

and fixed in position by the nut 6 screwed on the threaded portion 2*d* of the axle 2.

In the first embodiment of the axle bearing assembly of the present invention, in the axle bearing assembly shown in FIG. 1, the end surface 2*e* of the press-fit portion 2*c* of the axle 2 is accurately processed to provide a reference surface (hereinafter referred to as the reference surface 2*e*) for measuring the negative bearing clearance present upon completion of the assembly, as will be later described. The reference surface 2*e* may preferably be ground simultaneously with the raceway surface 2*a* and shoulder portion 2*b* as by using a grinding stone 15 shown in FIG. 14. With this arrangement, the precision of the dimensions P1 and L1 (the axial dimension from the shoulder portion 2*b* to the reference surface 2*e*) can be secured. The differences of the axle bearing assembly of this embodiment from the conventional one shown in FIG. 15 reside in three points, that the inner ring 3 abuts against the shoulder portion 2*b* of the axle 2 with no clearance therebetween, that the reference surface 2*e* is provided for measuring the negative bearing clearance present upon completion of the assembly, and that the presence of the negative bearing clearance upon completion of the assembly is assured by using the reference surface 2*e*.

The bearing clearance, in the bearing processing, can be set to a desired negative bearing clearance by controlling and selectively combining the pitch P0 and groove diameter of the two rows of raceway surfaces 1*a* and 1*b* of the outer ring 1, the axial dimension P1 from the shoulder portion 2*b* of the raceway surface 2*a* of the axle 2 and the groove diameter, and the axial dimension P2 from the smaller end surface of the raceway surface 3*a* of the inner ring 3 and the groove diameter. Therefore, unlike the conventional axle bearing assembly, there is no need to control the bearing clearance by the tightening torque on the nut in the assembling process and the setting of the bearing clearance can be reliably made. Furthermore, there is no danger of causing a variation in the bearing clearance upon completion of the assembly. And the negative bearing clearance thus set to a desired value is measured by a measuring method to be described below and by assuring this, the reliability for the bearing life is greatly improved.

In the process for press-fitting inner ring 3, the axial bearing clearance (Δa) is measured in the order shown in FIGS. 2 through 6.

First, as shown in FIG. 2, the inner ring 3 is press-fitted on the press-fit portion 2*c* of the axle 2 by using a press-fitting jig 10 having a recess (or pawl) 10*a* with a predetermined depth H. With the front end of the press-fitting jig 10 placed to abut against the larger diameter end surface (the back face) 3*b* of the inner ring 3, the inner ring 3 is pushed toward the shoulder portion 2*b* of the axle 2 until the bottom of the recess 10*a* of the press-fitting jig 10 abuts against the end of the axle 2, whereupon the inner ring 3 stops moving. Thereby, the press-fitting of the inner ring 3 is once stopped. At this point of time, the smaller diameter end surface (the front face) of the inner ring 3 is not abutting against the shoulder portion 2*b*, with a predetermined spacing S defined therebetween, and the axial bearing clearance is positive. Such state can be achieved by controlling the depth H of the press-fitting jig 10, the axial dimension L1 from the shoulder portion 2*b* of the axle 2 to the reference surface 2*e* for the press-fit portion 2*c*, the axial dimension L2 from the reference surface 2*e* to the axle end, and the width of the inner ring 3.

Then, in this state, the axial dimension A from the back face 3*b* (which is the reference surface for the inner ring 3) of the inner ring 3 to the reference surface 2*e* for the axle 2 is measured (FIG. 3) and the axial bearing clearance $\Delta a'$ is measured from the amount of axial movement of the outer ring 1 (FIG. 4).

Thereafter, as shown in FIG. 5, the inner ring 3 is press-fitted by using another press-fit jig 11 until it abuts against the shoulder portion 2*b* of the axle 2. And after the press-fitting has been completed, the axial dimension B between the back face 3*b* of the inner ring 3 and the reference surface 2*e* for the axle 2 is measured (FIG. 6). With the above operation thus completed, the negative axial bearing clearance A a can be found from $\Delta a=\Delta a'-(A-B)$. Alternatively, as shown in FIG. 5, it is possible to measure the press-fitting stroke C of the inner ring 3 effected by the press-fitting jig 11 and find the negative axial bearing clearance Δa from $\Delta a=\Delta a'-C$.

The axial bearing clearance measuring methods described so far are used to make measurements by using the back face 3*b* of the inner ring 3 and the end surface 2*e* of the press-fit portion 2*c* of the axle 2 as reference surfaces; however, as shown in FIGS. 7–11, it is also possible to make measurements by using the back face 3*b* of the inner ring 3 and the end surface 2*f* of the axle 2 as reference surfaces.

In addition, the bearing clearance measuring methods described above are each applicable to an axle bearing assembly of the type shown in FIG. 15 in which a spacing is defined between the inner ring and the shoulder portion of the axle (in this case, it is desirable to use a method which controls the press-fitting stroke). Further, they are also applicable to an axle bearing assembly of the type in which a pair of inner rings having raceway surfaces opposed to the two rows of raceway surfaces of the outer ring are fitted on the axle.

In a second embodiment of the axle bearing assembly of the present invention, the axle 2 in the axle bearing assembly shown in FIG. 1 is provided with a single axial air passage 2*h* and a plurality of radial air passages 2*i*, as shown enlarged in FIG. 12. The axial air passages 2*h* extends along the axis of the axle 2 and opens at one end thereof to the outside. The plurality of radial air passages 2*i* extend radially of the axle 2 and each communicate at one end thereof with the other end of the axial air passage 2*h* and open at the other end thereof to the outside in the vicinity of the shoulder portion. When the bearing clearance is to be measured, the axial air passage 2*h* will have an compressed air source 22 connected to one end thereof through detector means 20, such as a pneumatic-to-electric transducer, and a regulator 21.

The bearing clearance, in the bearing processing, can be set to a desired negative bearing clearance by controlling and selectively combining the pitch P0 and groove diameter of the two rows of raceway surfaces 1*a* and 1*b* of the outer ring 1, the axial dimension P1 from the shoulder portion 2*b* of the raceway surface 2*a* of the axle 2 and the groove diameter, and the axial dimension P2 from the front face of the raceway surface 3*a* of the inner ring 3. Therefore, unlike the conventional assembly, there is no need to control the bearing clearance by the tightening torque on the nut during the assembling and the setting of the bearing clearance can be reliably made. Furthermore, there is no danger of causing a variation in the bearing clearance upon completion of the assembly. In addition, as for the axle 2, if the raceway surface 2*a*, shoulder portion 2*b*, press-fit portion 2*c*, and the end surface 2*e* of the press-fit portion 2*c* are simultaneously ground as by using a grinding stone 15 shown in FIG. 14, the precision of the dimensions P1 and L1 (the axial dimension

from the shoulder portion 2*b* to the reference surface 2*e*) is secured, thereby facilitating said selective combination. And, the negative bearing clearance thus set to a desired value is measured by a measuring method to be described below, and by assuring this, the reliability for the bearing life and the like is greatly increased.

In the process of press-fitting the inner ring 3, the axial bearing clearance (Δa) is measured in the order shown in FIGS. 13A–13D.

First, as shown in FIG. 13A, the inner ring 3 is press-fitted on the press-fit portion 2*c* of the axle 2 by using a press-fitting jig 10 having a recess (or pawl) 10*a* with a predetermined depth H. With the front end of the press-fitting jig 10 placed to abut against the back face 3*b* of the inner ring 3, the inner ring 3 is pushed toward the shoulder portion 2*b* of the axle 2 until the bottom of the recess 10*a* of the press-fitting jig 10 abuts against the end of the axle 2, whereupon the inner ring 3 stops moving. Thereby, the press-fitting of the inner ring 3 is once stopped. At this point, the front face of the inner ring 3 is not abutting against the shoulder portion 2*b*, with a predetermined spacing S defined therebetween, and the axial bearing clearance is positive. Such state can be achieved by controlling the depth H of the press-fitting jig 10, the axial dimension L1 from the shoulder portion 2*b* of the axle 2 to the reference surface 2*e* for the press-fit portion 2*c*, the axial dimension L2 from the end surface 2*e* to the axle end, and the width of the inner ring 3.

Then, in this state, compressed air X is fed from one end of the axial air passage 2*h* (FIG. 13B). At this time, the axial air passage 2*h* has a compressed air source 22 connected to one end thereof through detector means 20 and a regulator 21 in the manner shown in FIG. 12. The compressed air X from the compressed air source 22 is set to a given pressure value by the regulator 21, whereupon it is fed to the axial air passage 2*h* through the detector means 20 and then it is blown out of the spacing S through the radial air passage 21. Since the size of the spacing S is proportional to the back pressure, amount of flow and flow rate of the compressed air X, it is possible to find the size of the spacing S by detecting them by the detector means 20. After the spacing S has been found in this manner, the axial bearing clearance Δa' is measured from the amount of axial movement of the outer ring 1 (FIG. 13C).

Thereafter, as shown in FIG. 13D, the inner ring 3 is press-fitted on the shoulder portion 2*b* of the axle 2 until it abuts against the shoulder portion 2*b* of the axle 2 by using another press-fitting jig 11. The press-fitting stroke at this time is S' (=S). With the above operation thus completed, it is possible to find the negative axial bearing clearance Δa from Δa=Δa'–S.

In the above embodiment, the press-fitting jig 10 having the predetermined depth H has been used as means for once stopping the press-fitting of the inner ring 3 (FIG. 13A); however, as an alternative, it is possible to feed the compressed air X from the beginning of the press-fitting to thereby press-fit the inner ring 3 by a suitable jig while controlling the spacing S, and once stop the press-fitting of the inner ring 3 when the spacing S takes a desired value. Further, upon completion of the press-fitting of the inner ring 3, in this state a lubricant such as grease or the like may be sealed in the bearing.

Further, the bearing clearance measuring method in this embodiment is likewise applicable to an axle bearing of the type in which a pair of inner rings having raceway surfaces opposed to the two rows of raceway surfaces of an outer ring are fitted on an axle. Further, it is also applicable (by providing an air passage) to an axle bearing assembly of the type in which a spacing W is defined between the inner ring and the shoulder portion of the axle, as shown in FIG. 15. In this case, by finding the spacing W in the same manner upon completion of the press-fitting of the inner ring, as described above, it is possible to find the negative axial bearing clearance Δa from Δa=Δa'–(S–W).

In the bearing clearance measuring methods in the embodiments described above (the first bearing clearance measuring method shown in FIGS. 2 though 6, the second bearing clearance measuring method shown in FIGS. 7 though 11, and the third bearing clearance measuring method shown in FIGS. 12 through 13A–13D), a lubricant such as grease may be sealed in the bearing simultaneously with the bearing clearance measurement before or after the press-fitting of the inner ring 3. In this case, a lubricant may be fed to the bearing through the space between the outer and inner rings 1 and 3 or between the outer ring 1 and the axle 2 (from the end side) from a lubricant feeding line which has means for detecting the amount of lubricant, adjusting means for adjusting the delivery pressure and amount of delivery of lubricant, and a lubricant supply source. Alternatively, in the case of the embodiments shown in FIGS. 12 and 13A–13D, a lubricant may be fed to the bearing through the passages 2*h* and 2*i* after the measurement of the bearing clearance and before the press-fitting of the inner ring 3 (the process between FIGS. 13B and 13C or the process between FIGS. 13C and 13D). In addition, the connections between the detecting means, adjusting means and supply sources of the lubricant feeding line may be determined as required, preferably in accordance with the air feeding means shown in FIG. 12. Further, these assemblies may be housed in a single box to be thereby made an integral feeding assembly.

The feeding of the lubricant may, of course, be effected separately from the bearing clearance measurement; however, by effecting it simultaneously with the bearing clearance measurement as described above, the axle bearing assembly can be inspected and assembled in a shorter time, thereby reducing the working time and equipment operating time, a fact which leads to a cost reduction.

Further, in order to protect the axle bearing assembly from extraneous substances, such as dust, dirt, mud, sand, and water, a seal may be installed between the outer ring 1 and the axle 2 and/or between the outer and inner rings 1 and 3 in the region which is outside the balls 4*a* and 4*b*. In FIG. 1, an arrangement is shown by way of example in which two seals 34*a* and 34*b* are installed. However, the seal configuration, the attaching construction and the like may be suitably selected according to the conditions for use and are not limited particularly to the arrangement shown in FIG. 1. The provision of seals protects the axle bearing assembly from extraneous substances such as dirt and the like and also protects the balls, raceway surfaces, retainers and the like from extraneous substances. In addition, the attachment of seals is effected after the sealing-in of the lubricant.

What is claimed is:

1. An axle bearing assembly comprising an outer ring having a flange formed on the outer periphery thereof and two rows of raceway surfaces formed on the inner periphery thereof, an inner ring having a raceway surface formed on the outer periphery thereof in opposed relation to one of the raceway surfaces of the outer ring, an axle formed on the outer periphery thereof with a raceway surface opposed to the other raceway surface of the outer ring and also with a press-fit portion continuous therewith through a shoulder portion and adapted to have the inner ring press-fitted

thereon, and two rows of balls angularly contacting with one row of the raceway surfaces of the outer ring and the raceway surface of the inner ring and with the other row of the raceway surfaces of the outer ring and the raceway surface of the axle, wherein the inner ring is press-fitted until it abuts against the shoulder portion of the axle and in that bearing clearance is negative.

2. A method of measuring the bearing clearance in an axle bearing assembly which comprises an outer ring having a flange on the outer periphery thereof and two rows of raceway surfaces formed on the inner periphery thereof, an inner ring having a raceway surface formed on the outer periphery thereof in opposed relation to one of the raceway surfaces of the outer ring, an axle formed on the outer periphery thereof with a raceway surface opposed to the other raceway surface of the outer ring and also with a press-fit portion continuous therewith through a shoulder portion and adapted to have the inner ring press-fitted thereon, and two rows of balls angularly contacting with one row of the raceway surfaces of the outer ring and the raceway surface of the inner ring and with the other row of the raceway surfaces of the outer ring and the raceway surface of the axle, said method comprising, in press-fitting the inner ring on the press-fit portion of the axle, the steps of once stopping the press-fitting while the axial bearing clearance is positive, measuring in this state the axial dimension (A) between a reference surface for the axle and a reference surface for the inner ring and an axial bearing clearance (Δa'), continuing the press-fitting until completion, and measuring the axial dimension (B) between the reference surface for the axle and the reference surface for the inner ring, thereby

finding the negative axial bearing clearance (Δa) upon completion of the assembly from Δa=Δa'−(A−B).

3. A method of measuring the bearing clearance in an axle bearing assembly which comprises an outer ring having a flange formed on the outer periphery thereof and two rows of raceway surfaces formed on the inner periphery thereof, an inner ring having a raceway surface formed on the outer periphery thereof in opposed relation to one of the raceway surfaces of the outer ring, an axle formed on the outer periphery thereof with a raceway surface opposed to the other raceway surface of the outer ring and also with a press-fit portion continuous therewith through a shoulder portion and adapted to have the inner ring press-fitted thereon, and two rows of balls angularly contacting with one row of the raceway surfaces of the outer ring and the raceway surface of the inner ring and with the other row of the raceway surfaces of the outer ring and the raceway surface of the axle, said method comprising, in press-fitting the inner ring on the press-fit portion of the axle, the steps of once stopping the press-fitting while the axial bearing clearance is positive, measuring an axial bearing clearance (Δa') in this state, and measuring the amount of press-fitting stroke (C) continuing from this state to the completion of the press-fitting of the inner ring, thereby finding the negative axial bearing clearance (Δa) upon completion of the assembly from Δa=Δa'−C.

4. A method of measuring the bearing clearance in an axle bearing assembly which comprises an outer ring having a flange formed on the outer periphery thereof and two rows of raceway surfaces formed on the inner periphery thereof, an inner ring having a raceway surface formed on the outer periphery thereof in opposed relation to one of the raceway surfaces of the outer ring, an axle formed on the outer periphery thereof with a raceway surface opposed to the other raceway surface of the outer ring and also with a press-fit portion continuous therewith through a shoulder portion and adapted to have the inner ring press-fitted thereon, and two rows of balls angularly contacting with one row of the raceway surfaces of the outer ring and the raceway surface of the inner ring and with the other row of the raceway surfaces of the outer ring and the raceway surface of the axle,

said method comprising the steps of forming the axle with an air passage which opens to the outside in the vicinity of the shoulder portion, once stopping, in press-fitting the inner ring on the press-fit portion of the axle, the press-fitting while the axial bearing clearance is positive, finding the spacing (S) between the shoulder portion of the axle and the end surface of the inner ring opposed thereto from such detected values as the back pressure and the amount of flow or flow rate of compressed air blown out of the spacing (S) through the air passage, measuring the axial bearing clearance (Δa') in this state, and press-fitting the inner ring until it abuts against the shoulder portion of the axle,

thereby finding the negative axial bearing clearance (Δa) from Δa=Δa'−S.

* * * * *

arshall-Hull, Debbie

From: on behalf of Fink, Herschel P.
To: COI-Audit
Subject: COI Memo

CLIENT(s): ILJIN USA (Michigan subsidiary of Korean company)

[x] NEW CLIENT or [ ] EXISTING CLIENT / CLIENT #

OTHER INVOLVED & AFFECTED PARTIES & BRIEF DESCRIPTION OF THE PARTIES:	ATTORNEYS FOR THE INVOLVED PARTIES:
Adverse Party: NTN Corporation (a Japanese company)	

DESCRIPTION OF THE MATTER: Act as local counsel in action for declaratory judgment of invalidity and noninfringement of U.S. patent. We will be local counsel to Jerold Schneider of Akerman Senterfitt firm of West Palm Beach.

PARTNER(s) IN CHARGE: Herschel P. Fink

REPLY TO: Herschel P. Fink & Patricia A. McKanna

*** The information contained herein is strictly confidential ***

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US005620263A

United States Patent [19]

Obtsuki et al.

[11] Patent Number: 5,620,263

[45] Date of Patent: Apr. 15, 1997

[54] AXLE BEARING ASSEMBLY AND METHOD OF MEASURING BEARING CLEARANCES

[75] Inventors: Hisashi Obtsuki, Iwata-gun; Motoharu Niki, Iwata; Yasunori Terada, Iwata; Nobuyoshi Yamashita, Iwata, all of Japan

[73] Assignee: NTN Corporation, Osaka, Japan

[21] Appl. No.: 448,328

[22] PCT Filed: Oct. 28, 1994

[86] PCT No.: PCT/JP94/01830

§ 371 Date: Jul. 18, 1995

§ 102(e) Date: Jul. 18, 1995

[87] PCT Pub. No.: WO95/12072

PCT Pub. Date: May 4, 1995

[30] Foreign Application Priority Data

Oct. 28, 1993 [JP] Japan 5-269362
Oct. 29, 1993 [JP] Japan 5-271479

[51] Int. Cl.[6] F16C 33/60; F16C 43/04

[52] U.S. Cl. 384/517; 29/898.09; 384/500; 384/537

[58] Field of Search 384/450, 499, 384/500–502, 504–506, 512, 517, 519, 537, 543, 544, 563; 73/593, 862.49, 862.59; 33/517, 701, 710, 37

[56] References Cited

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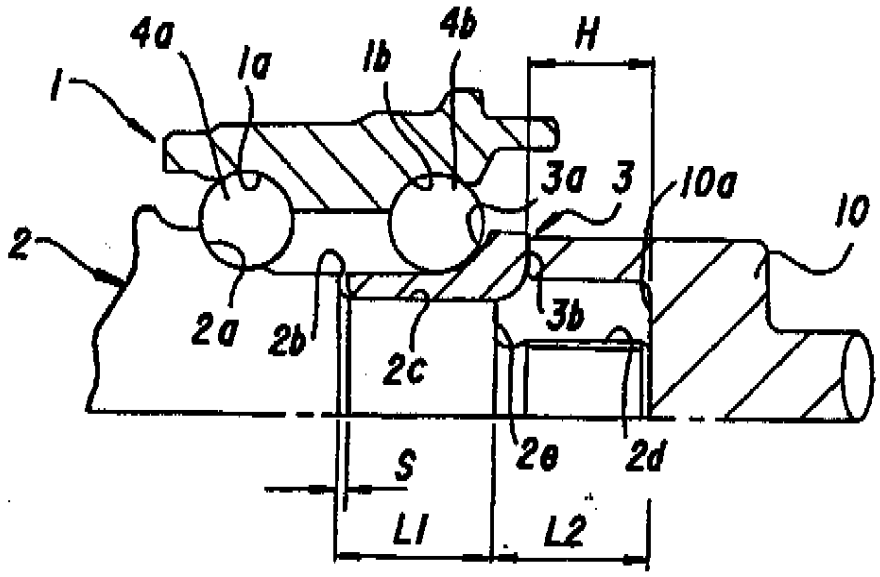
Primary Examiner—Thomas R. Hannon
Attorney, Agent, or Firm—Nikaido, Marmelstein, Murray & Oram LLP

[57] ABSTRACT

The end surface 2c of the press-fit portion 2c of the axle 2 is machined with high precision to serve as a reference surface for measuring the negative bearing clearance upon completion of the assembly. The inner ring 3 is press-fitted on the press-fit portion 2c of the axle 2 and is fixed in position by the nut 6 screwed on the threaded portion 2d of the axle 2. In this axle bearing assembly, the inner ring 3 abuts against the shoulder portion 2d of the axle 2 with no clearance defined therebetween, and the negative bearing clearance is assured.

4 Claims, 8 Drawing Sheets



11/99 **CIVIL COVER SHEET** COUNTY IN WHICH THIS ACTION AROSE: Oakland **ORIGINAL**

The JS-44 civil cover sheet and the information contained herein neither replace nor supplement the filing and service of pleadings or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk of Court for the purpose of initiating the civil docket sheet.

I. (a) PLAINTIFFS
ILJIN USA

(b) County of Residence of First Listed: Oakland

DEFENDANTS
NTN corporation

County of Residence of First Listed: Oakland
NOTE: IN LAND CONDEMNATION CASES, USE THE LOCATION OF THE LAND INVOLVED.

(c) Attorneys (Name, Address and Telephone Number)
Jerold I. Schneider
222 Lakeview Avenue
West Palm Beach, FL 33401 (561) 671-3661

Attorneys (if Known)

II. BASIS OF JURISDICTION (Place an "X" in One Box Only)

- ☐ 1 U.S Government Plaintiff
- ☒ 3 Federal Question (U.S. Government Not a Party)
- ☐ 2 U.S. Government Defendant
- ☐ 4 Diversity (Indicate Citizenship of Parties in Item III)

III. CITIZENSHIP OF PRINCIPAL PARTIES (Place an "X" in One Box for Plaintiff and One Box for (For Diversity Cases Only)

	PLA	DEF		PLA	DEF
Citizen of This State	☒ 1	☐ 1	Incorporated *or* Principal of Business In This State	☐ 4	☒
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- ☐ 690 Other

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- ☐ 720 Labor/Mgmt. Relations
- ☐ 730 Labor/Mgmt. Reporting & Disclosure Act
- ☐ 740 Railway Labor Act
- ☐ 790 Other Labor Litigation
- ☐ 791 Empl. Ret. Inc. Security Act.

BANKRUPTCY
- ☐ 422 Appeal 28 USC 158
- ☐ 423 Withdrawal 28 USC 157

PROPERTY RIGHTS
- ☐ 820 Copyrights
- ☐ 830 Patent
- ☐ 840 Trademark

SOCIAL SECURITY
- ☐ 861 HIA (1395ff)
- ☐ 862 Black Lung (923)
- ☐ 863 DIWC/DIWW (405(g))
- ☐ 864 SSID Title XVI
- ☐ 865 RSI (405(g))

FEDERAL TAX SUITS
- ☐ 870 Taxes (U.S. Plaintiff or Defendant)
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OTHER STATUTES
- ☐ 400 State Reapportionment
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- ☐ 444 Welfare
- ☐ 440 Other Civil Rights

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- Habeas Corpus:
- ☐ 530 General
- ☐ 535 Death Penalty
- ☐ 540 Mandamus & Other
- ☐ 550 Civil Rights
- ☐ 555 Prison Condition

(PLACE AN "X" IN ONE BOX ONLY)

V. ORIGIN

☒ 1 Original Proceeding ☐ 2 Removed from State Court ☐ 3 Remanded from Appellate Court ☐ 4 Reinstated or Reopened ☐ 5 Transferred from another district (specify) ☐ 6 Multidistrict Litigation ☐ 7 Appeal to District Judge from Magistrate Judgment

VI. CAUSE OF ACTION (Cite the U.S Civil Statute under which you are filing and write brief statement of cause. Do not cite jurisdictional statutes unless diversity.)

Title 28, U.S.C. Section 1338, Title 35, U.S.C. Section 1 et seq.

VII. REQUESTED IN COMPLAINT: ☐ CHECK IF THIS IS A CLASS ACTION UNDER F.R.C.P. 23 $ DEMAND CHECK YES only if demanded in complaint: JURY DEMAND: ☐Yes ☒No

VII. RELATED CASE(S) IF ANY (See instructions) JUDGE_____ DOCKET NUMBER_____

DATE 1/10/06

SIGNATURE OF ATTORNEY OF RECORD
x Jerold I. Schneider
Jerold I. Schneider (P20029)

URSUANT TO LOCAL RULE 83.11

1. Is this a case that has been previously dismissed? ☐ Yes ☒ No

If yes, give the following information:

Court: _____

Case No.: _____

Judge: _____

2. Other than stated above, are there any pending or previously discontinued or dismissed companion cases in this or any other court, including state court? (Companion cases are matters in which it appears substantially similar evidence will be offered or the same or related parties are present and the cases arise out of the same transaction or occurrence.) ☐ Yes ☒ No

If yes, give the following information:

Court: _____

Case No.: _____

Judge: _____

Notes: